

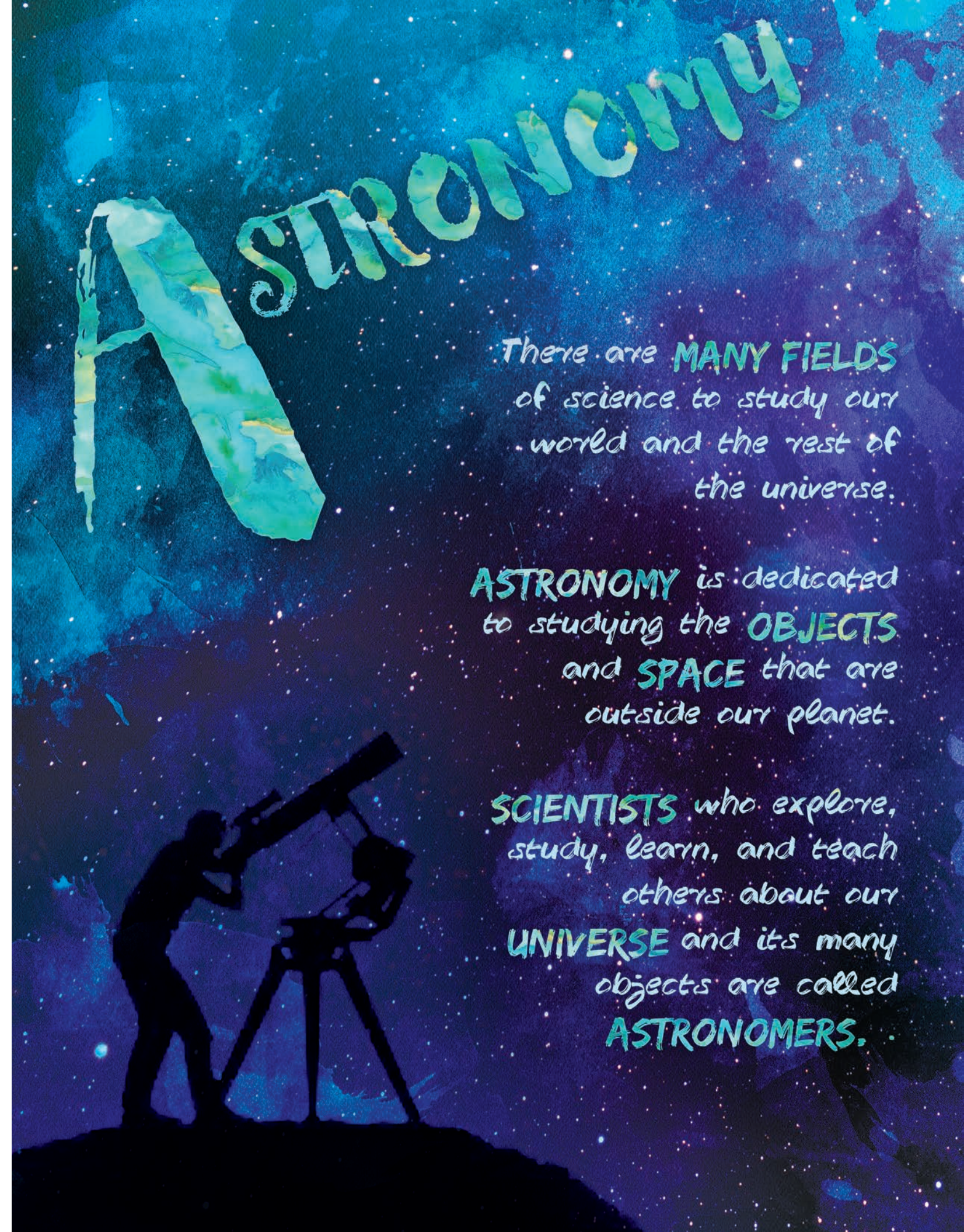


# THE ABC'S OF EXOPLANETS

A PAINTED EXPLORATION OF THE WHATS AND WHYS OF  
STAR-ORBITING PLANETS OUTSIDE OUR SOLAR SYSTEM



**Q:**  
What objects would you be interested  
in studying in our universe?



There are **MANY FIELDS**  
of science to study our  
world and the rest of  
the universe.

**ASTRONOMY** is dedicated  
to studying the **OBJECTS**  
and **SPACE** that are  
outside our planet.

**SCIENTISTS** who explore,  
study, learn, and teach  
others about our  
**UNIVERSE** and its many  
objects are called  
**ASTRONOMERS.**



Q:  
Why do astronomers use the term binary  
to describe these star systems?

A Binary

Star System is a

**GROUP OF TWO STARS**

that orbit each other or the  
same central point. Astronomers

believe at least **HALF OF THE STARS**  
in our galaxy are part of **BINARY SYSTEMS!**

An exoplanet orbiting a binary star system  
could have **MULTIPLE SUNRISSES** and **SUNSETS!**



**BINARY STAR SYSTEM**

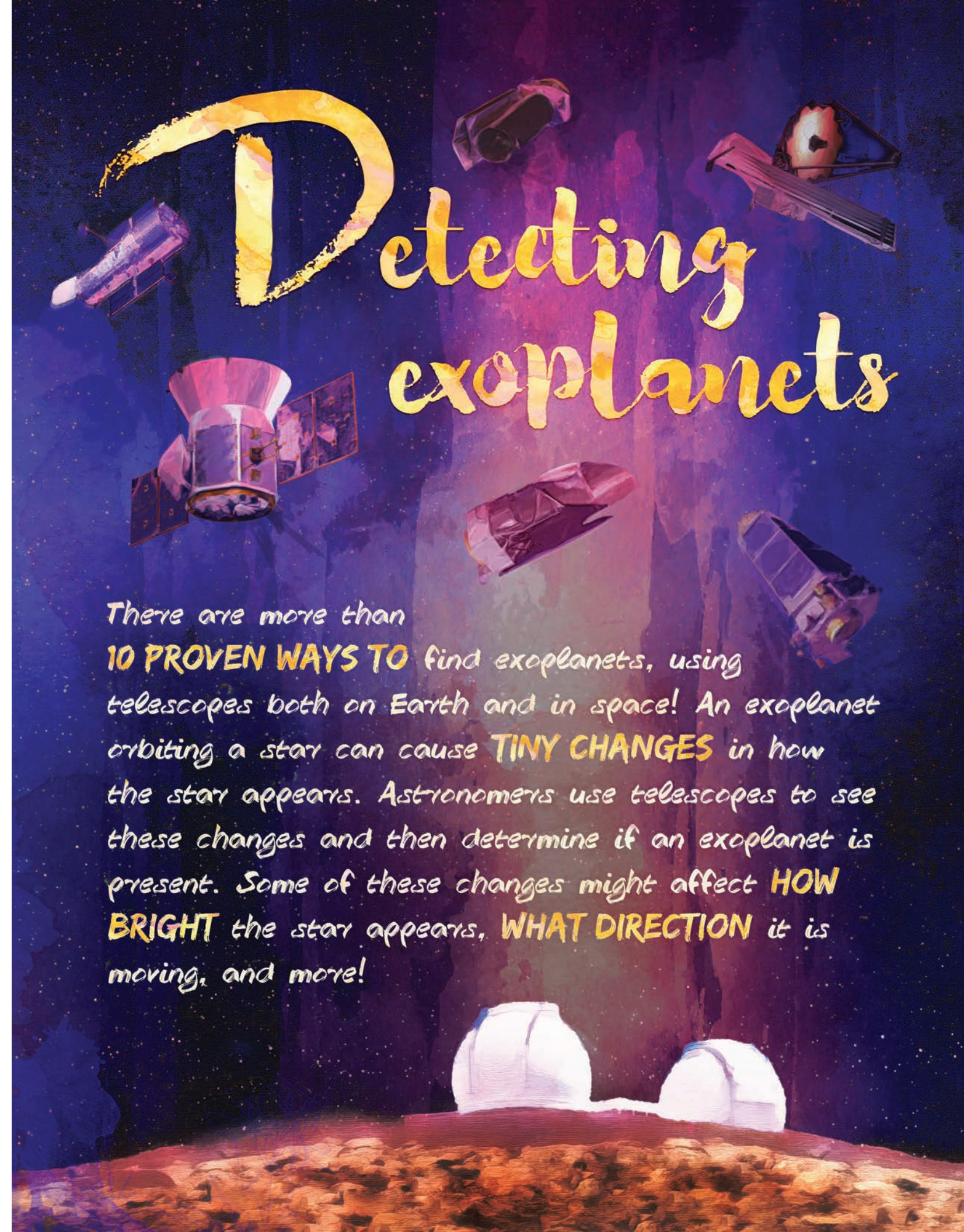


**Q:**  
How is the composition of Earth different  
from the composition of Jupiter? Of Venus?





**Q:**  
What tools do astronomers use  
to detect exoplanets?





**Q:**  
How are planets in our solar system different from exoplanets?  
How might they be the same?

# Exoplanets

On a clear dark night,  
you can see **THOUSANDS  
OF STARS** in the night  
sky. Each of those stars  
may have planets orbiting  
it, called **EXOPLANETS!**

Exoplanets do not belong to our solar  
system. Some may be similar  
to our solar system's planets,  
but some may be

**VERY  
DIFFERENT.**



**Q:**  
What is one way a planet could become  
a free-floating planet?

# Free Floating Planet

Not every

**EXO  
PLANET**

can be  
bound to  
orbiting  
a **STAR**.

If an  
exoplanet  
is ejected from  
its star system,  
that planet **FLOATS  
FREELY** in space;  
these exoplanets  
are also sometimes  
called **ROGUE PLANETS!**  
Scientists estimate there could  
be hundreds of billions of  
**FREE-FLOATING** planets  
in the Milky Way.



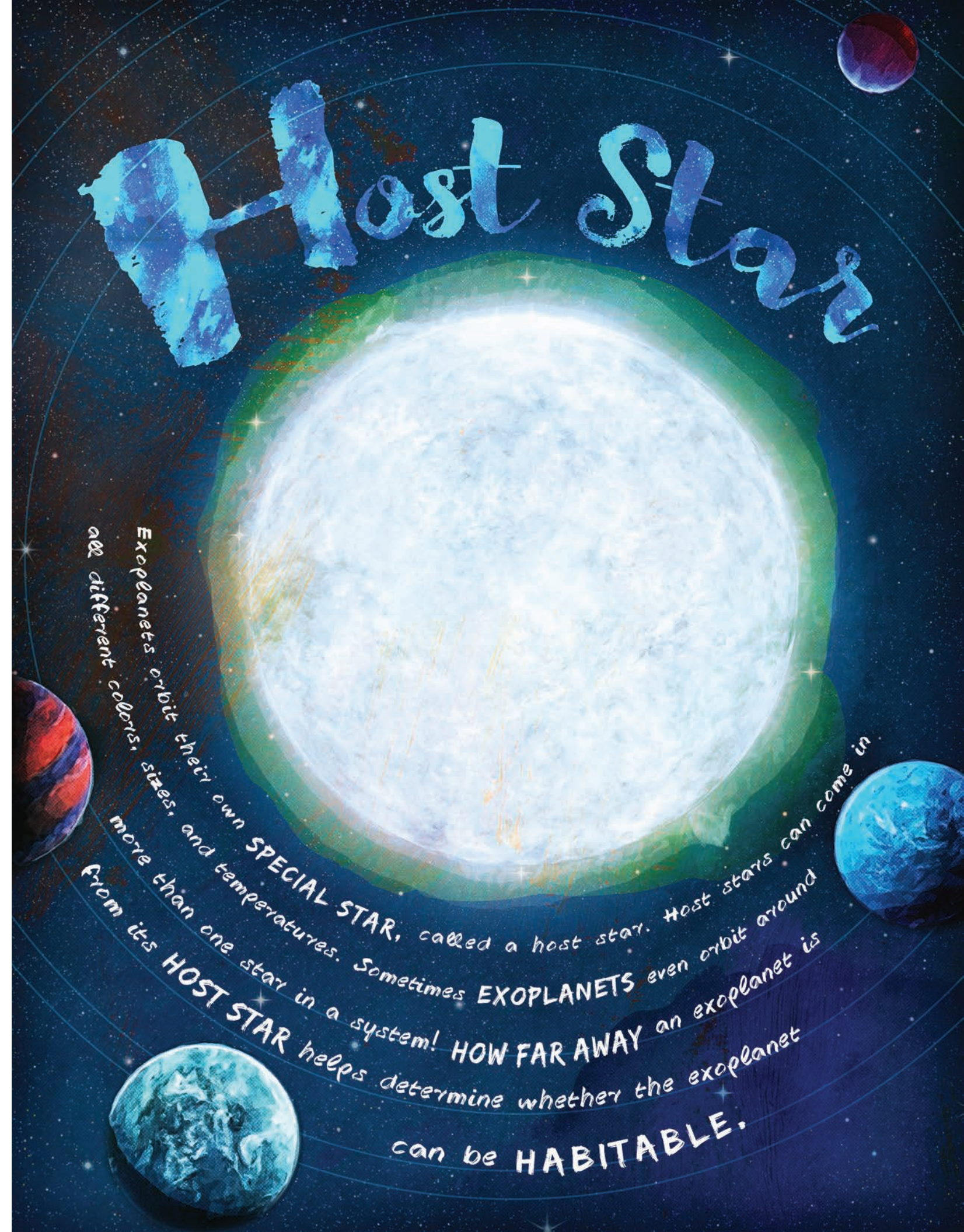
**Q:**  
What makes a gas giant different  
from a rocky world?





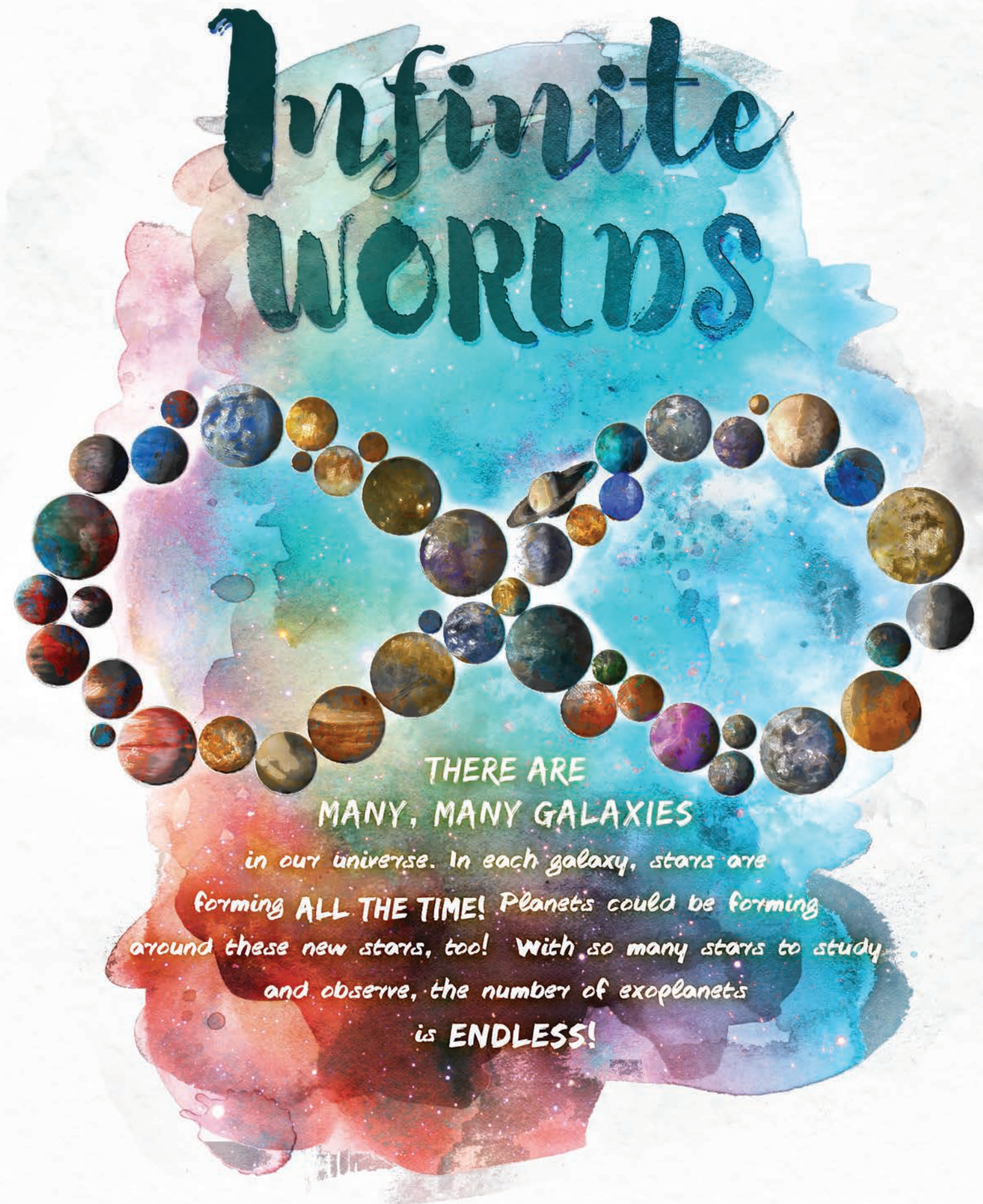
Q:

Why do you think an exoplanet's distance from its host star helps determine whether life could exist there?



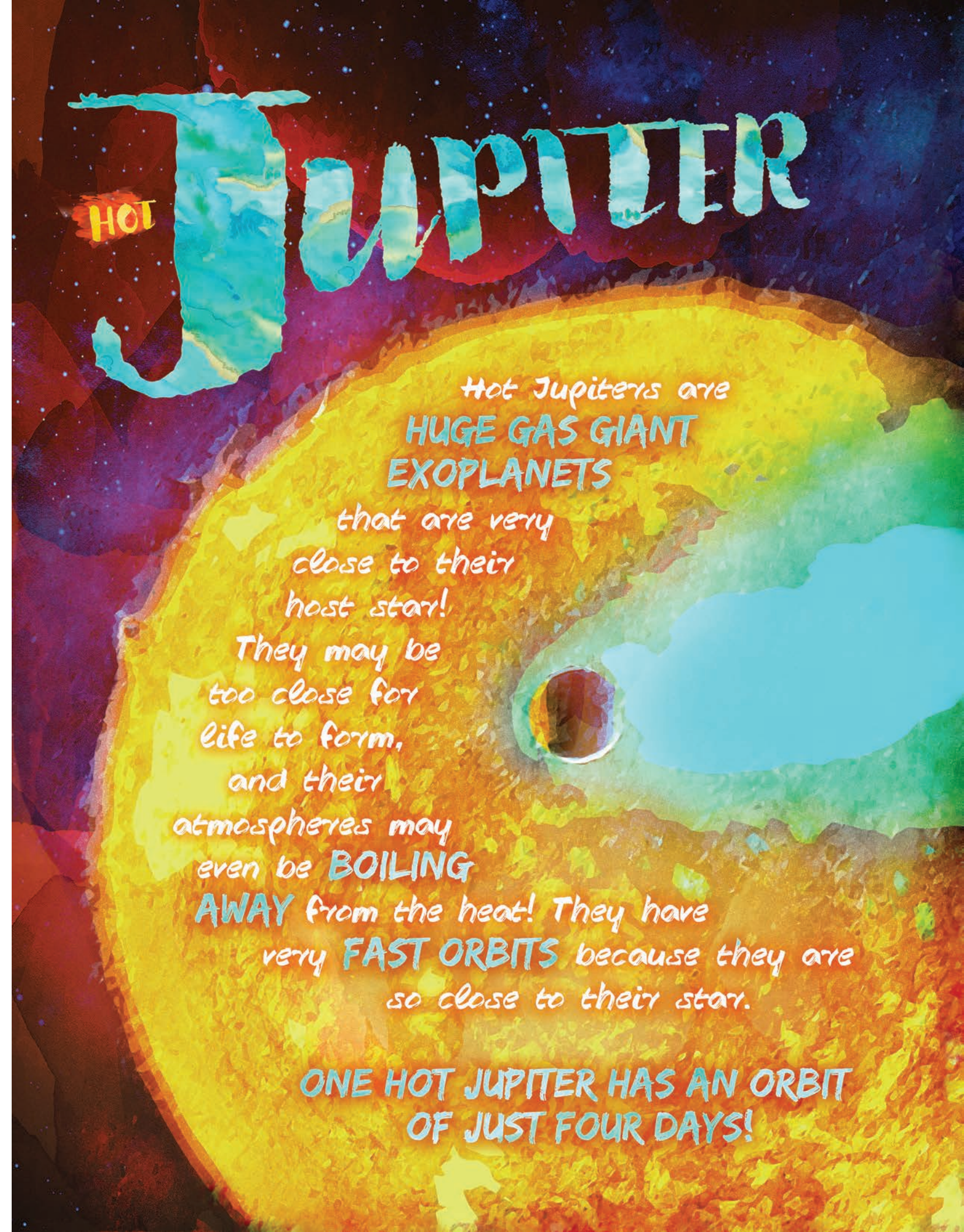


**Q:**  
Why is it difficult to count  
how many exoplanets exist?





**Q:**  
If Jupiter moved to be a “hot Jupiter,” what would be the new order of planets in our solar system?



**HOT**

# JUPITER

Hot Jupiters are  
**HUGE GAS GIANT  
EXOPLANETS**

that are very  
close to their  
host star!

They may be  
too close for  
life to form,  
and their  
atmospheres may  
even be **BOILING  
AWAY** from the heat! They have  
very **FAST ORBITS** because they are  
so close to their star.

**ONE HOT JUPITER HAS AN ORBIT  
OF JUST FOUR DAYS!**



**Q:**  
Can you name any other  
famous astronomers?





Q:

Why do you think astronomers create other units to measure the distance of objects in the universe?

# LIGHT YEARS

Here on Earth, we have many DIFFERENTLY SIZED UNITS to measure how far away something may be or how big something is. Astronomers commonly use the LIGHT YEAR, the distance light travels in one year.

ONE LIGHT YEAR is equal to  
**5,878,499,810,000 MILES!** One of the  
CLOSEST known exoplanets to Earth is **4.22 LIGHT  
YEARS AWAY.**



**Q:**  
Why are exomoons  
difficult to detect?



*Many planets in our solar system have moons.  
Astronomers believe exoplanets  
might have moons, too!*

*They would be called exomoons and  
are very difficult to find because they are  
smaller than planets and  
**DO NOT PRODUCE THEIR OWN LIGHT.***

*Astronomers are developing  
new techniques to help make  
finding them easier.*



**Q:**  
How can astronomers tell mini-Neptunes  
are different than super-Earths?

# mini NEPTUNE

Some  
**EXOPLANETS**  
resemble the  
**GAS PLANETS**  
in our own  
solar system,  
but they're  
**MUCH SMALLER!**

These planets  
are called

**MINI-NEPTUNES.** They are closer in size to  
Earth than Neptune, but astronomers  
can tell they're gas planets because  
they are much **LESS DENSE**  
than a rocky world.





**Q:**  
If you have visited an observatory,  
what objects did you observe?

Different types of scientists have different places where they conduct their research and collect their data. Astronomers use **TELESCOPES** to collect data and study celestial objects. These telescopes are housed in **OBSERVATORIES**.

# Observatory

These ground-based observatories use **VISIBLE LIGHT** and radio, and are located in various locations on the surface of the Earth. Many observatories have special times when guests can **VISIT!** Check out an observatory near you!





**Q:**  
How long do you predict it would take  
to travel to Proxima Centauri B?

# Proxima Centauri b

The closest exoplanet to  
Earth orbits the star  
Proxima Centauri. It's  
called **PROXIMA CENTAURI B**,  
and it is only a little over  
**FOUR LIGHT-YEARS AWAY!**  
It would take many years  
to travel to this exoplanet  
because we cannot move  
as **FAST AS LIGHT**,  
but **IMAGINE** what  
new information  
we could  
**DISCOVER!**



**Q:**  
What questions do you have  
about exoplanets?

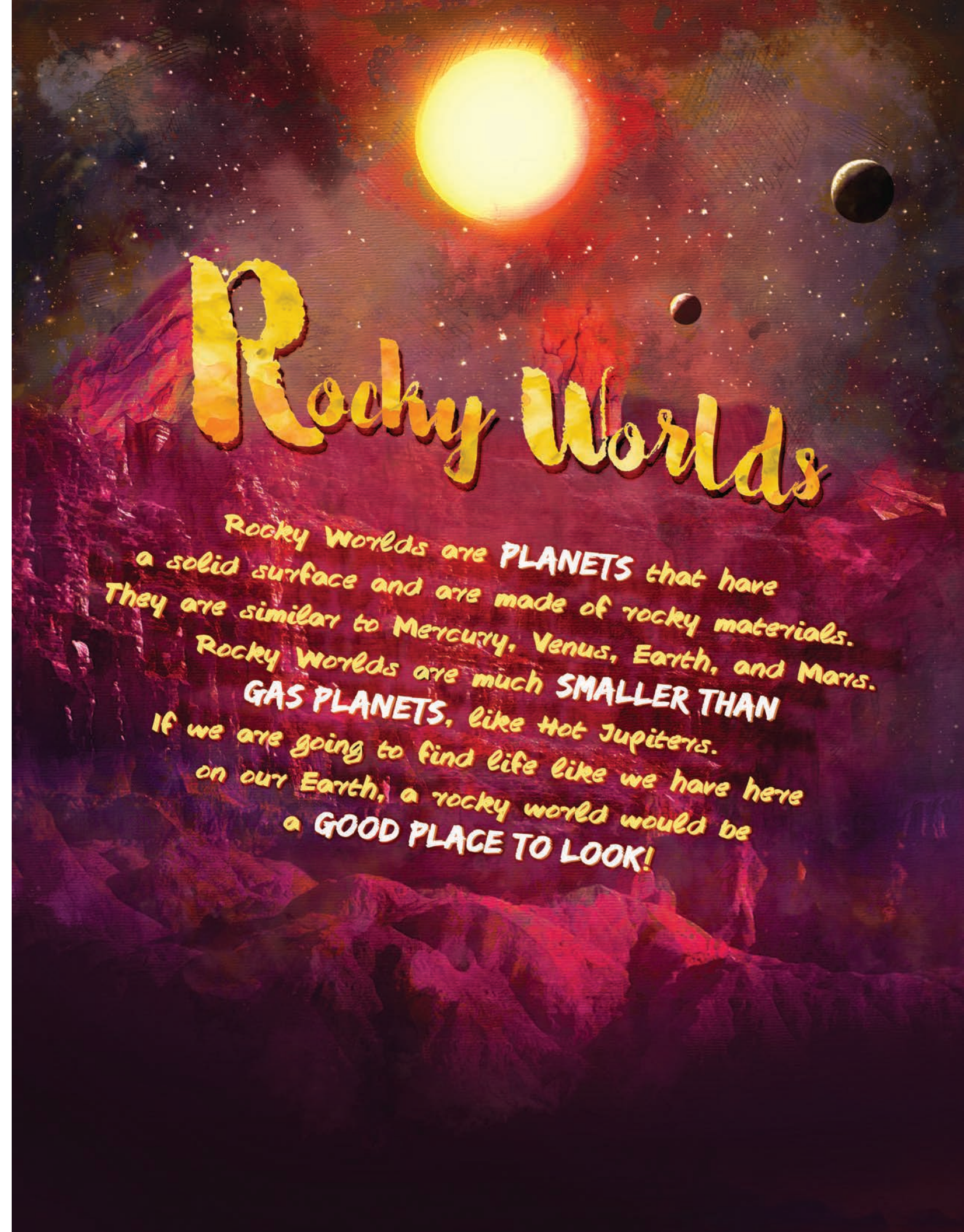
# uestions

With astronomers  
discovering **NEW**  
**WAYS** to find  
exoplanets and new  
observatories being  
built, the quest for  
**NEW WORLDS** is just  
beginning! Many  
questions are being  
asked, scientists are  
studying data and new  
missions are being designed  
to help find  
**ANSWERS.**



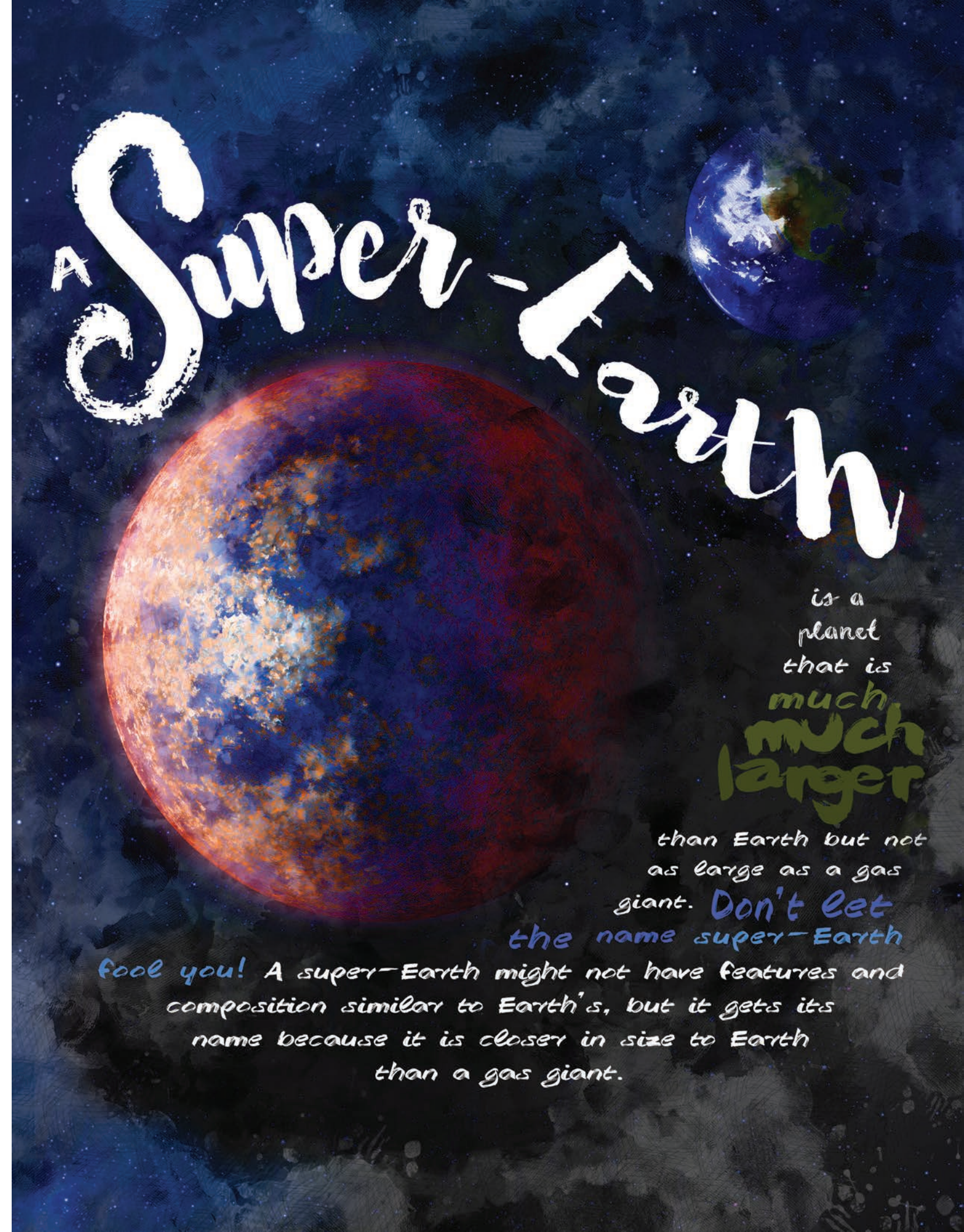


**Q:**  
Why would a rocky world be  
a good place to look for life?





**Q:**  
What makes a super-Earth similar to Earth?  
What makes a super-Earth different from Earth?





Q:  
What planets do we see  
transiting our sun?

# Transit

When an exoplanet orbits in front of its **HOST STAR**, it **BLOCKS** some of the **LIGHT**. Astronomers call this a transit. Each transit will block a different amount of light because exoplanets can be **DIFFERENT SIZES** and **DIFFERENT DISTANCES** from their host star. This is one way for astronomers to find new **EXOPLANETS**.



**Q:**  
How many different objects in the universe  
can you name in 30 seconds? Go!



# universe

*Everything we know that  
exists is located in the **UNIVERSE**.*

*The universe is the term astronomers use to describe all of space.*

*Astronomers believe it is **GROWING AND GROWING!***

## HOW BIG WILL THE UNIVERSE GET?

*Our galaxy, the **MILKY WAY**, is one part of the universe.*

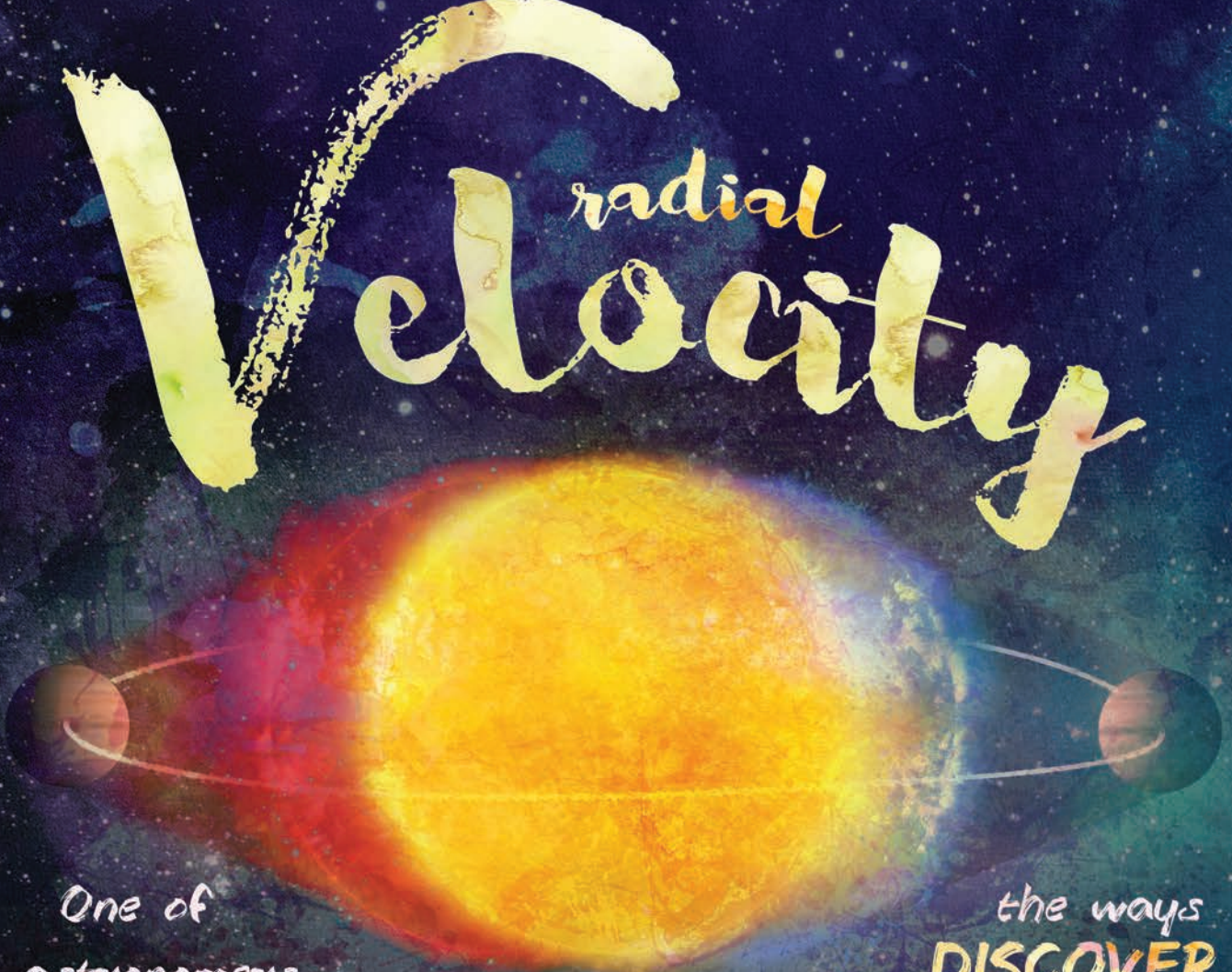
*How many exoplanets are in our galaxy?*



# universe



**Q:**  
What colors show that stars are moving  
due to an exoplanet's orbit?



One of the ways  
astronomers **DISCOVER**  
exoplanets is called **RADIAL VELOCITY**.  
**STARS** aren't completely still in space when an  
exoplanet is orbiting them. The planet **TUGS** on the  
star ever so **SLIGHTLY**, causing it to move in a small  
circle. These movements affect a star's **LIGHT**  
**SPECTRUM**. When the planet is moving **TOWARD US**,  
the **COLORS** will appear **SHIFTED** toward the color  
**BLUE**. When moving **AWAY** from us, the color spectrum  
is **SHIFTED** toward **RED**. These shifts can be measured  
and show a planet is in **ORBIT**.



**Q:**  
What types of life forms do you think  
live on a water world?

# WATER WORLD

A WATER WORLD, or an  
ocean planet, is a planet  
that astronomers think  
could be entirely  
**COVERED BY WATER.**

With all of that  
water, it may be  
hard to have  
**LAND-BASED** life

forms. However, if  
the planet could have life,

imagine all of the new types  
of **WATER LIFE** that  
could be discovered!





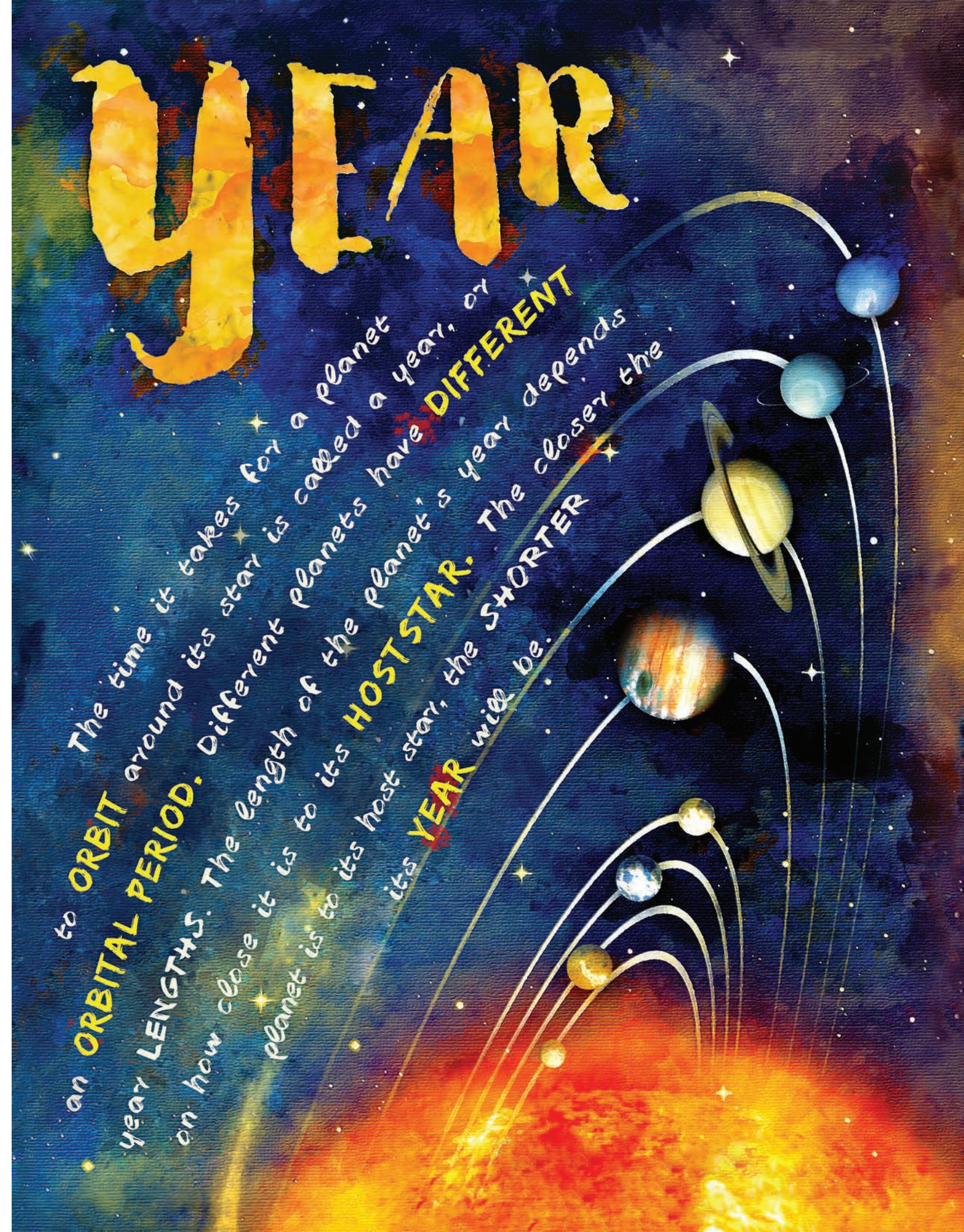
**Q:**  
How are X-rays used  
to study objects on Earth?



Astronomers call  
the light we see with our eyes  
**"VISIBLE LIGHT,"**  
but visible light only makes up  
a small portion of all the light  
in the **UNIVERSE!**  
X-rays are a special type of light  
astronomers use to observe exoplanets  
transiting their host star.  
**X-RAYS** provide **DIFFERENT INFORMATION**  
than visible light.

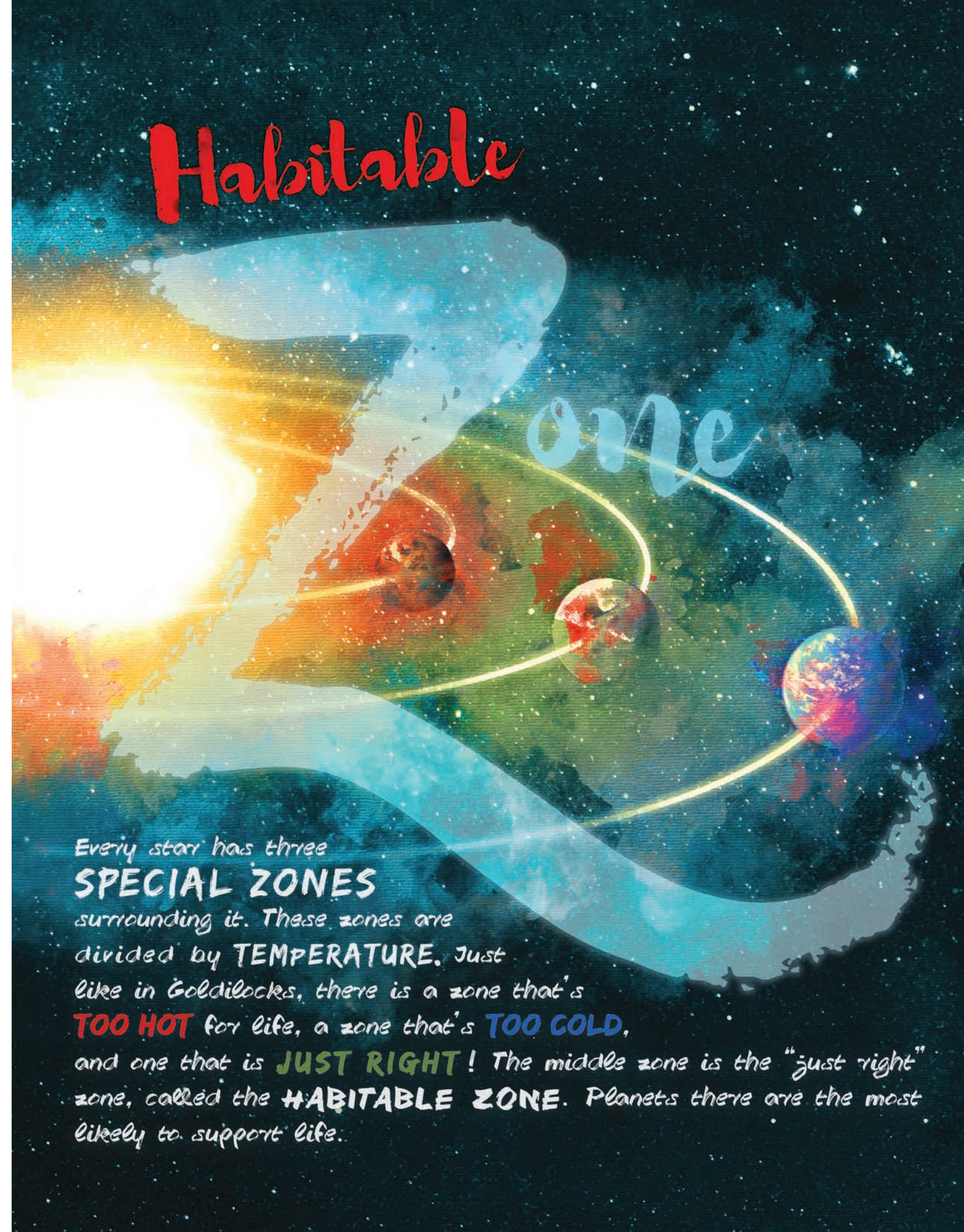


**Q:**  
What planets have longer years than Earth  
in our solar system?





**Q:**  
Which planets do you think are in  
the habitable zone in our solar system?



# Habitable

# one

Every star has three  
**SPECIAL ZONES**  
surrounding it. These zones are  
divided by **TEMPERATURE**. Just  
like in Goldilocks, there is a zone that's  
**TOO HOT** for life, a zone that's **TOO COLD**,  
and one that is **JUST RIGHT**! The middle zone is the "just right"  
zone, called the **HABITABLE ZONE**. Planets there are the most  
likely to support life.





National Aeronautics and Space Administration

**Goddard Space Flight Center**

8800 Greenbelt Road

Greenbelt, MD 20771

[tess.gsfc.nasa.gov](http://tess.gsfc.nasa.gov)

[www.nasa.gov](http://www.nasa.gov)

NP-2018-2-171-GSFC